Migration to Commercial Communications for Geostationary Services

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Satellite and Information Service

NSOSA

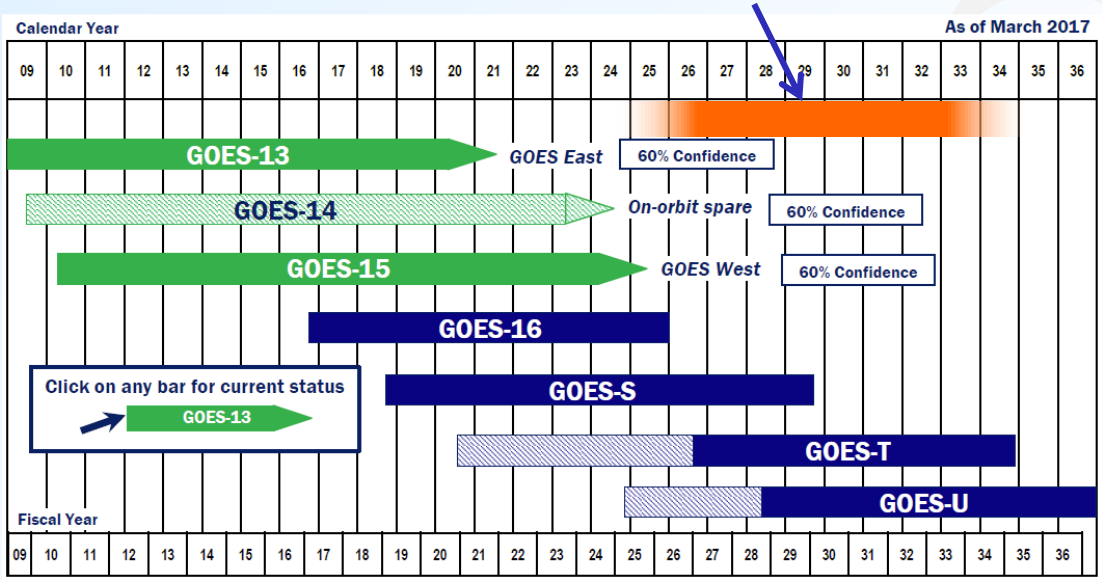
OSAAP Guiding NESDIS' Future

AEROSPACE

Future Communication Service Needs

- ***Distribute high-speed data with strict, fixed latency requirements***
  - *Rates up to 100 Mbits/sec -- From a small number (1-5) of injection points to a larger number (~100) of distribution points*
- ***Distribute medium to low-speed data***
  - *Rates < 1 Mbit/sec -- From a small number (1-5) of injection points to a large number (hundreds) of distribution points, including austere terminals*
- ***Collect small amounts of data***
  - *10 messages per day of a few hundred bytes -- From > 1000 remote sensor locations*
- ***Geo-location and short message data***
  - *From thousands of mobile ground terminals*
  - *Minimize the user terminal footprint*

Service overlap (notional)



Source: https://www.nesdis.noaa.gov/content/our-satellites

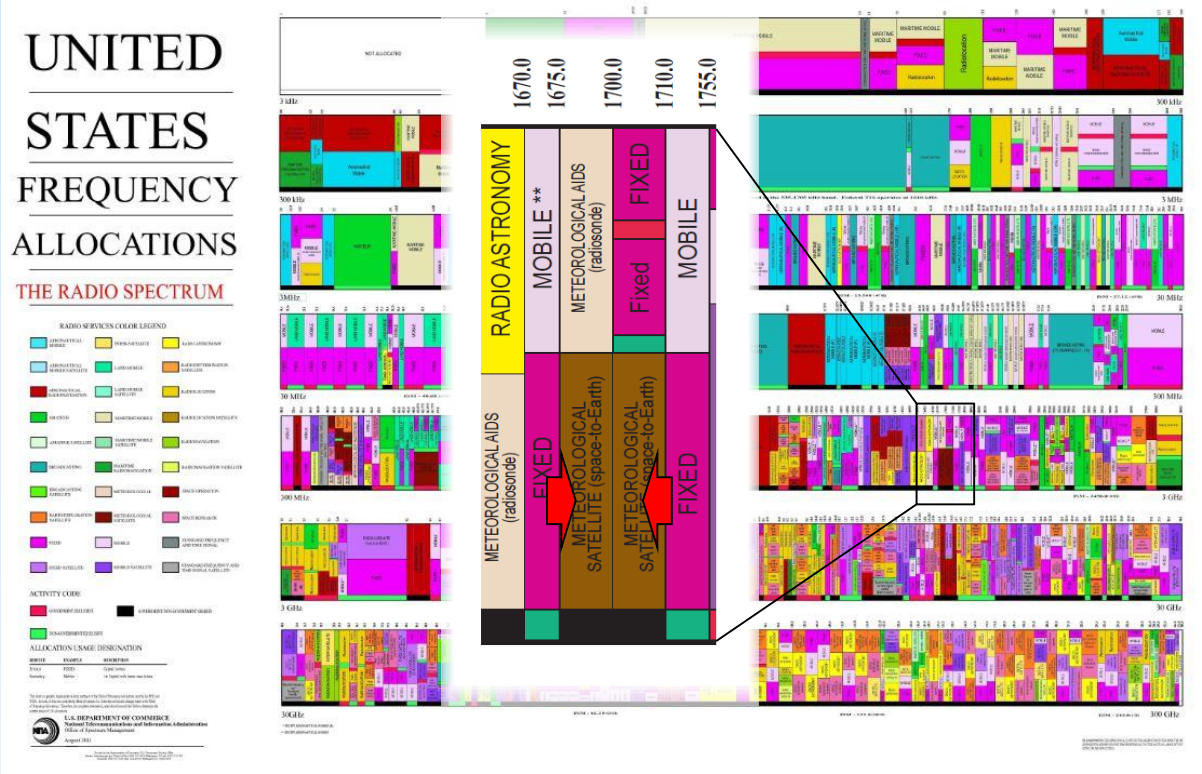
Focus of the Study:
Should we maintain the legacy services -- or selectively transition to commercial services?

ALTERNATIVES CONSIDERED

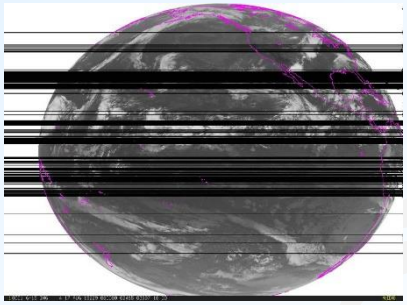
- ***Continue legacy services from US Government GEO satellites***
  - *Baseline communications payload:*
    cost "X" = 8.8% of the cost of four GEO satellites, 15 year mission life
    mass "Y" = 26% of satellite mass
    power "Z" = 58% of satellite power ← Major driver
- ***Move legacy payloads to a commercial host satellite***
  - *Construction cost about the same, and payload dominates host power budget… such a tenant would probably have to pay a major fraction of mission cost*
  - *Must pay sufficient hosting fee to cover cost of money, risks, profit for 15 years*
  - *Might have to pay for more than 15 years if spacecraft survives*
    …these factors all tend to make commercial equal or more expensive than government-hosted for a power-intensive communications mission
- ***Replace the legacy with commercial equivalents***
  - *Leased transponders or satellite broadband Internet*
  - *Commercial terrestrial Internet, supported by content distribution network services, surplus dark fiber installations*
  - *Medium and low data rate services: satellite relays, intra-atmospheric relays*
  - *Low rate messaging and geolocation with satellite or cellular telephone*

Spectrum Congestion --
Cost isn't the only driver

- ***Growing demand is squeezing NOAA's access to RF spectrum***
- ***Spectrum allocation is under consideration for auction***



Source: https://www.ntia.doc.gov/files/ntia/publications/spectrum_wall_chart_aug2011.pdf



This image was taken on August 17, 2015. The black areas in the image are areas in which weather observations have been lost due to spectrum interference during the testing of the 1675 to 1680 MHz band. Credit: NOAA

Source: https://www.nesdis.noaa.gov/content/noaa%E2%80%99s-environmental-observations-spectrum-matters

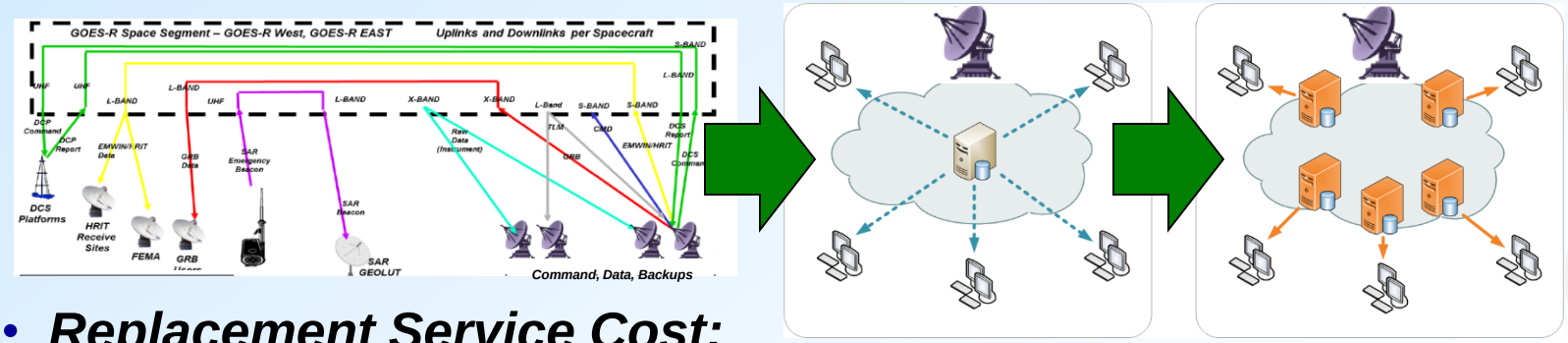
Factors Included in Cost Comparisons

- ***Replacement Service Costs***
  - *Data rates*
  - *Data volumes*
  - *Number of Distribution/Collection Points*
- ***User Terminal Costs***
  - *Number of terminals*
  - *Terminal replacement rates*
  - *Terminal costs*
  - *Existing SWAP constraints*
- ***Excluded:***
  - *Cost to redesign multiple types of user platforms for use of commercial terminals and services*

Costs shown on remaining slides are expressed as a percentage of "X" = 8.8% of a baseline mission total cost that provides legacy services (4 GEO spacecraft, 15 years)

Commercial Alternative for GOES Re-Broadcast Service (GRB)

- ***Mission Area: Near-Real-Time Distribution of GOES Images***
- ***Replacement: Commercial terrestrial Internet supported by content distribution network service***
  - *Entails a restructuring of the outgoing NOAA data flow*
    - *From: Current satellite streaming approach*
    - *To: An internet product-oriented approach accessed by users when needed*



- ***Replacement Service Cost:***
  - *11% of "X"*
  - *Rates up to 100 Mbit/sec, from a small number (1-5) of injection points to a larger number (~100) of distribution points in western hemisphere*
  - *Ships or other mobile platforms would use satellite internet*

Commercial Alternative for Data Collection Platform (DCP)

- ***Mission Area: Deployed Sensor Collection***
- ***Replacement: Satellite messaging or email service***
  - *Either Globalstar Packet Data service with GSP 1620 packet data modem, or Iridium Short Burst Data (SBD) service using OEM transceiver embedded in sensor terminal*
  - *Globalstar is currently the lower cost option*

- ***Replacement Service Cost:***
  - *1.5% to 3.9% of "X"*
  - *Collection of small amounts of data (10 messages per day of a few hundred bytes) from >1000 remote sensor locations*

Commercial Alternative for High Rate Information Transfer (HRIT)

- ***Mission Area: Near-Real-Time Low Res Images, Near-Real-Time Deployed sensor data dissemination***
- ***Replacement: Commercial terrestrial Internet, plus commercial satellite internet for disadvantaged users***
  - *Best provider depends on location -- Some possible providers:*
    - *Iridium Pilot 134 kbps bi-directional*
    - *Globalstar wiFi*
    - *Inmarsat BGAN services*
    - *…several others*


- ***Replacement Service Cost:***
  - *11% of "X" (Includes EMWIN service)*
  - *Rates < 1 Mbit/sec -- From a small number (1-5) of injection points to a large number (hundreds) of distribution points, including austere terminals*

Commercial Alternative for Emergency Managers Weather Information Network (EMWIN)

- ***Mission Area: Emergency Weather Information***
- ***Replacement: Commercial terrestrial Internet, plus either existing VHF rebroadcast or commercial satellite internet for disadvantaged users***
  - *Best provider depends on location and data rate needs, e.g.*
    - *HughesNet, Exede, dishNet*

- ***Replacement Service Cost:***
  - *11% of "X" (Included with HRIT service)*
  - *Rates < 1 Mbit/sec -- From a small number (1-5) of injection points to a large number (hundreds) of distribution points, including austere terminals*

Commercial Alternative for Argos Data Collection System (A-DCS)

- ***Mission Area: Tag/platform tracking and data***
- ***Replacement: Satellite messaging or email service***

  - *Partial solution: Globalstar Packet Data service with GSP 1620 packet data modem or wildlife collars for larger animals, with issues:*
    - *Small animals may need Argos or Argos-like service provided by future intra-atmospheric services (Google Loon, Facebook, or similar)*
    - *Or, shift to mechanisms used for smaller species: data logging supported by wireless, VHF, UHF, acoustic; or capture and download via wired connection*
    - *Or, use International Cooperation for Animal Research Using Space (ICARUS) payload on the International Space Station*
  - ***A-DCS appears to be less amenable to commercial replacement***
    - *Replacement cost is high*
    - *Argos could still be used (low impact on spacecraft), Argos has features not replicated on commercial*

- ***Replacement Service Cost (partial):***
  - *15 - 36% of "X", depending on accounting for terminals (60% of cost)*

NO Commercial Alternative for SAR Emergency Beacon/SARSAT

- **Mission Area: Search and rescue**
- **Replacement: No direct commercial alternatives**
  - *…that are compatible with a large base of installed user terminals*
  - *…constrained to a particular frequency band*
  - *However there are plenty of governmental (both domestic and foreign) platforms planned to carry SARSAT services, notably GPS Block III satellites and the Galileo Global Navigation Satellite System*
  - *Shifting away from GEOSAR to medium-earth orbit (MEO) platforms to meet needs of the SARSAT mission:*
    - *Provide location information independent of an external source*
    - *Overcome line-of-sight obstructions*
    - *More robust link budget for user terminals*

- **Mission Service Cost:**
  - *No Commercial Solution Available*
  - *Payload has a small impact on host (government or commercial)*

Cost Summary

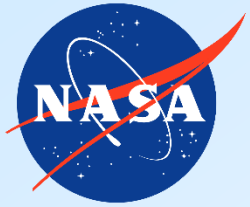
- ***GOES Re-Broadcast***
  - *Can be replaced with commercial Internet services supported by a Content Distribution Network* *cost:* *11% of "X"*
- ***Data Collection Platform (DCP)***
  - *Can be replaced w/ satellite messaging or email* *1.5-3.9%*
- ***High Rate Information Transfer (HRIT) and Emergency Managers Weather Information Network (EMWIN)***
  - *Can be replaced with commercial terrestrial Internet, plus existing VHF rebroadcast or commercial satellite internet for disadvantaged users* *11%*
- ***Argos Data Collection System (A-DCS) – Less amenable to replacement***
  - *Globalstar Packet Data service or wildlife collars is a partial commercial alternative, but it may be more cost effective to continue A-DCS* *15-36%*
- ***SARSAT: No commercial alternatives***
  - *GEOSAR being superseded by MEOSAR, rely on GPS/Galileo*

Compare Legacy Services to Total of Replacements relative to baseline mission cost *39-62%*

NET COST SAVINGS ~40-60% compared to baseline

Stakeholder Concerns Other Than Cost

- ***Sunk investment, large number of terminals***
  - *Affordability, ability to make changes*
- ***Compatibility of services with user missions***
  - *Commercial alternatives are not one-for-one replacements*
    - *Sometimes superior, but not in every respect*
  - *Preferences for satellite vs. terrestrial delivery*
  - *Disadvantaged users/locations, ability to use new/changing equipment*
  - *Ability to access commercial services (protocols, storage, timing, etc.)*
- ***Reliability/quality of commercial services***
  - *Commercial is usually high quality, guaranteed time to restore, but not able to supply extraordinary service compared to mainstream*
- ***International agreements, spectrum constraints***
- ***New ways of doing business***
  - *Planning horizon – shorter, driven by technology change*
  - *Consumer-driven – Government is just another consumer, adapts to what is available*
  - *Acceptability of Suppliers – Nationality, capacity, viability, market share*



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